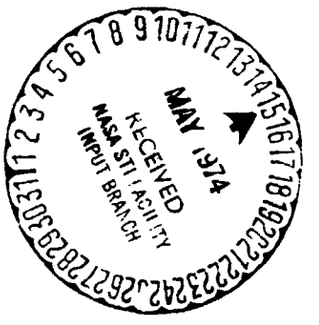
NASA TECHNICAL TRANSLATION NASA TT F-15,543

MARS-3: ASTROPHYSICAL STUDY OF THE LOWER ATMOSPHERE AND PLANET SURFACE

V. I. Moroz, L. V. Ksanfomaliti, and A. E. Nadzhip

Translation of "Nauchnaya sessiya otdeleniya obshchey fiziki i astronomii akademii nauk SSSR, 28-28 March, 1973," Uspekhi Fizicheskikh Nauk, Vol. 111, No. 3, October 1973, pp. 360-370



(NASA-TT-F-15543) MARS-3: ASTROPHYSICAL STUDY OF THE LOWER ATMOSPHERE AND PLANET SURFACE (Kanner (Leo) Associates) 6 p
HC $4.00 CSCL 03B

N74-22467

Unclas
G3/30 37246

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 APRIL 1974

STANDARD TITLE PAGE

1. Report No. NASA TT F-15,543	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle MARS-3: ASTROPHYSICAL STUDY OF THE LOWER ATMOSPHERE AND PLANET SURFACE		5. Report Date April 1974 6. Performing Organization Code
7. Author(s) V. I. Moroz, L. V. Ksanfomaliti, and A. E. Nadzhip, Section of General Physics and Astronomy, USSR Academy of Sciences		8. Performing Organization Report No. 10. Work Unit No. 11. Contract or Grant No.
9. Performing Organization Name and Address Leo Kanner Associates Redwood City, California 94063		13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration, Washington, D.C. 20546		14. Sponsoring Agency Code

15. Supplementary Notes

Translation of "Nauchnaya sessiya otdeleniya obshchey fiziki i astronomii akademii nauk SSSR, 28-29 March 1973," Uspekhi Fizicheskikh Nauk, Vol. 111, No. 3, October 1973, pp. 369-370

16. Abstract Results were reported from the following 4 Mars-3 experiments: 1)infrared brightness temperature measurements of Mars surface in 8-40 μm range; 2) Mars surface-relief determination from intensity variation of CO_2 quantity in 2 μm absorption band; 3) H_2O content in atmospheric measurement from intensity of 1.38 μm absorption band; 4) planet photometry in 5 narrow spectral bands within 3700-7000 Å range. Thermal inertia constant of Martian ground was about 0.006 cal cm^{-2} $sec^{-1/2}$ deg^{-1}. This is typical of dry dust at low pressure. Temperature difference between dark (warmer) and light surface areas was ∿10-15°C. In polar cap areas, temperatures close to CO_2 condensation temperature were recorded. A dust storm created an "antigreenhouse" effect. Altitudes along ground observation tracks varied from -2 to 5 km. Cloud altitude during the dust storm was of the order of 10 km. Water content was very low -- a few μm of precipitable water from Dec. to Feb. It increased in March to ∿20 μm, but above the polar caps H_2O content was under 0.5 μm. Comparison of Mars photometric profiles in the 0.7 μm and 1.4 μm regions showed a significant contrast increase at longer wavelengths during the storm. This agrees with a particle size of ∿ 1 μm. Total quantity of dust in the atmosphere is estimated to be about 10^9 tons.

17. Key Words (Selected by Author(s))	18. Distribution Statement
	Unclassified-Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	4	

MARS-3: ASTROPHYSICAL STUDY OF THE LOWER ATMOSPHERE AND PLANET SURFACE

V. I. Moroz, L. V. Ksanfomaliti, and A. E. Nadzhip,
Section of General Physics and Astronomy,
USSR Academy of Sciences

Three artifical satellites, the Soviet Mars-2 and Mars-3 /369* and the American Mariner-9 were sent into orbit around Mars during the opposition period in 1971. Research which was carried out by these satellites considerably increased our knowledge of the neighboring planet. We shall deal here with some results of four experiments carried out on Mars-3: 1) measurement of the infrared brightness of the temperature of the surface in the 8-40 μm range, 2) the determination of heights on the surface by the intensity of the absorption bands of CO_2 λ 2 μm, 3) measurement of the content of H_2O in the atmosphere by the intensity of the absorption band λ 1.38 μm and photometry in the unbroken spectrum on the fringes of this band, 4) photometry of the planet in five narrow spectral bands in the 3700-7000 Å range.

Problems, which are solved by the instruments enumerated are classical problems of the astrophysical research of Mars, which has been conducted during many years from Earth observations. The use of artificial satellites for conducting research on Mars makes it possible to increase space resolution (in an H_2O-photometer, for example, by up to 5 km on the planet's surface, instead of several thousands of kilometers for Earth observations), to avoid difficulties, caused by the absorption of H_2O and CO_2 in the Earth's atmosphere and carry out measurement at narrow angles of incidence and reflection, unobtainable from Earth, and especially to investigate the noctural side of the planet.

---

* Numbers in the margin indicate pagination in the foreign text.

Mars-3 has a period of approximately 12 days, and the distance in the pericenter of the orbit was from 1000 to 1500 km. Measurement was done during the seven times that the pericenter was passed; each time, the narrow band on the surface of the planet was scanned (on account of the satellite's movement) intersecting it from south to north in the ranges from 50-60° south latitude to 40-70° north latitude.

Measurement was begun in December and completed in March. There was a dust storm on Mars during the initial observation period, but in January it died down. Comparison of the December and February observations made it possible to study for the first time some properties of clouds, which almost completely cover the planet during dust storms.

The nature of the daily range of temperature of the surface is indicative of low thermal conductivity. The thermal inertia constant $(k\rho c)^{1/2} \approx 0.006$ cal·cm^{-2}sec$^{-1/2}$degree^{-1} is characteristic of dry dust at low pressure. The dark areas were 10-15° warmer than the light ones. In the northern polar cap area, temperatures were recorded approximate to the temperature of the condensation of CO_2 -- which is a basic component of the Martian atmosphere. It appeared that the dust storm has a significant influence on the planet's thermal conditions. During a dust storm, the surface was colder than in the "quiet" time when the atmosphere was transparent. Apparently, a temporary cloud layer, which forms during the dust storm period, creates a type of "antigreenhouse" effect. Dust clouds penetrate shortwave solar radiation worse than longwave planetary radiation; as a result, the surface cools, and the atmosphere heats up [1-3].

Altitudes, measured by CO_2 bands, normally agrees satisfactorily with results of ground radio location, where a comparison can be made. Altitudes along ground observation tracks

fluctuated from -2 to +5 km. There was some correlation between altitudes and albedo: if dark and light areas were adjacent, the dark section, in the majority of cases, was higher [1, 4]. The altitude of clouds during a storm was approximately 10 km, but the upper boundary, apparently, is very diffuse.

The water vapor content was very small even for Mars: the /370
few micrometers of precipitated water on the vertical column from December to February, in March increased, apparently, to 20 μm. The H_2O content is less than 0.5 μm over the northern polar cap. During the last opposition periods, ground measurement of the H_2O content (an average for the whole planet) showed a large amount of moisture (up to 60 μm) for the same season. A reduction in the amount of H_2O in the lower atmosphere was accompanied by a fall in hydrogen concentration in the upper atmosphere [5].

Comparison of photometric profiles of Mars in the 0.7 and 1.4 μm region shows that there is a considerable increase in contrast at longer wavelengths during a storm. This agrees with particles of approximately micrometer size. During a dust storm, bright ultraviolet clouds were observed, linked, apparently, with even smaller particles. The total amount of dust in the atmosphere during a dust storm was estimated as being 10^9 tons. Condensation clouds with submicrometer particles were observed in the area of the northern polar cap [1, 3].

REFERENCES

1. Moroz, V. I. and Ksanfomaliti, L. V., Vestn. AN SSSR (9), 10 (1972); Moroz, V. I. and Ksanfomaliti, L. V., Icarus 17, 408 (1972).

2. Moroz, V. I., Ksanfomaliti, L. V., Kasatkin, A. M., et al., DAN SSSR 208, 299 (1973); Moroz, V. I., Ksanfomaliti, L. V., Kunashev, B. S., et al., Ibid., p. 1048.

3. Moroz, V. I., Ksanfomaliti, L. V., Kasatkin, A. M., and Nadzhip, A. E., Kosm. Issl. 10, 925 (1972).

4. Moroz, V. I., Nadzhip, A. E., and Gil'barg, A. B., DAN SSSR 208, 77 (1973).

5. Dementyeva, N. N., Kurt, V. G., Smirnov, A. S., et al., Icarus 17, 475 (1972).